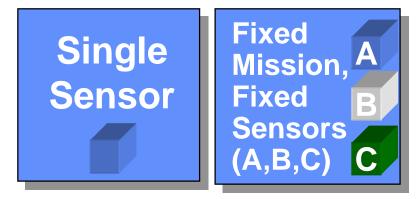
Future Embedded Computing Architectures

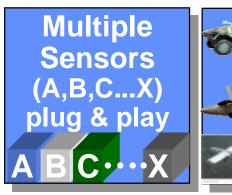
Robert B. Graybill
Program Manager
DARPA/ITO

Embedded Computing System Requirements Revolution

Have



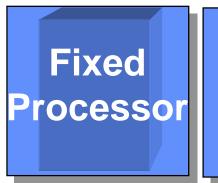
Could Have

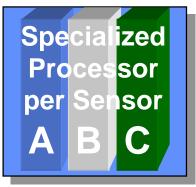




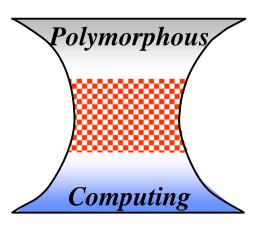
In-Mission Re-target -ability

BOUNDED MISSION CAPABILITY





DYNAMIC MISSION CAPABILITY



Challenge Applications



Tactical UAV (TUAV)

Observe
Ocient
O

Common Evolvable Computing Platform



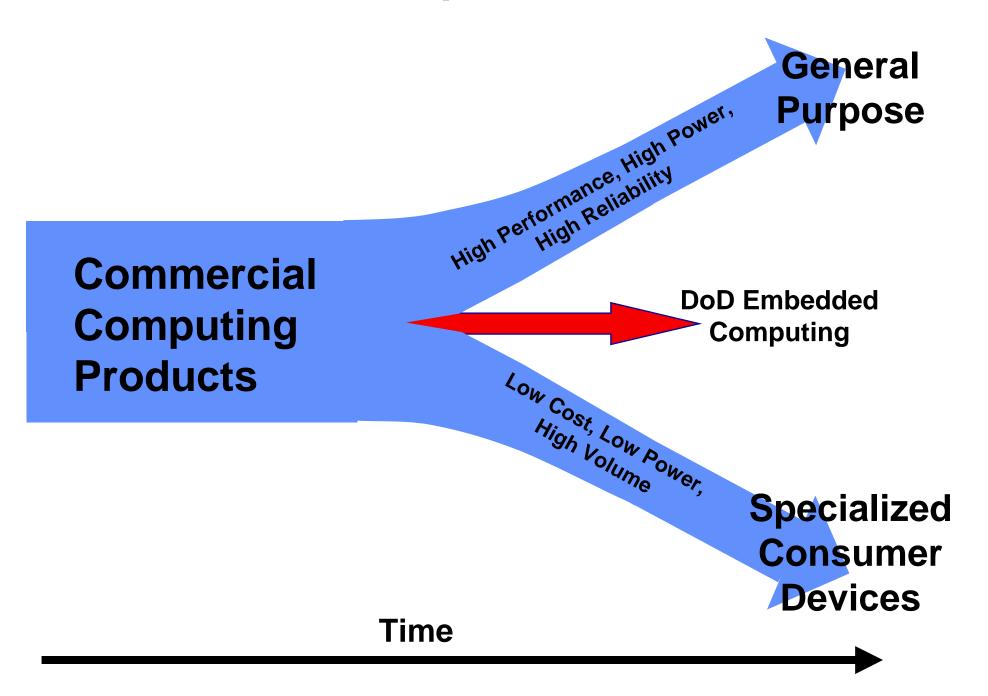
Manned C2/Infantry Squad
Future Combat Systems



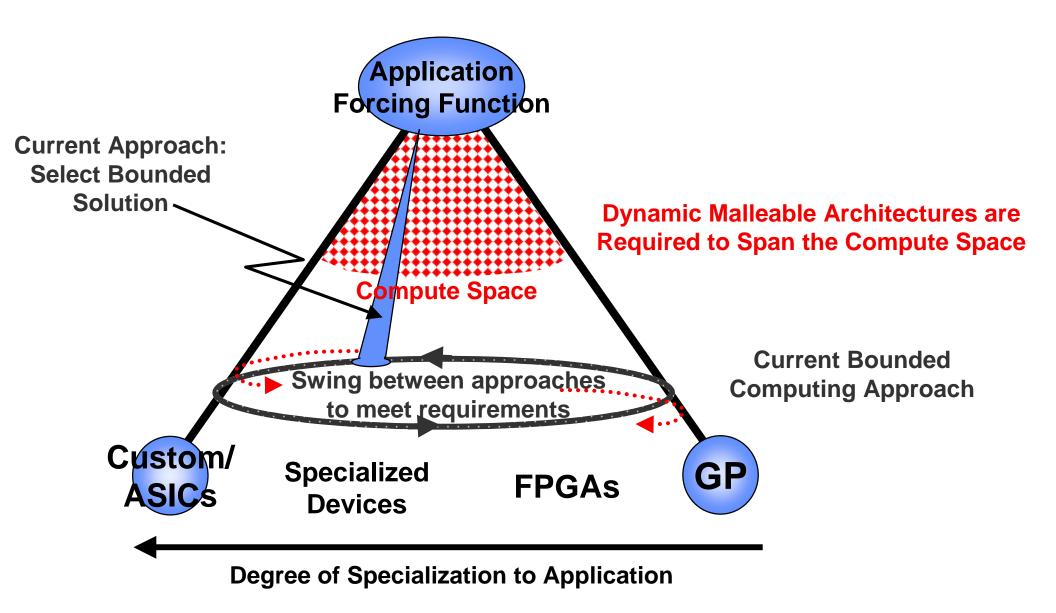
DoD Existing Platforms

Rapid Upgradability

Commercial Support of DoD Computing Requirements

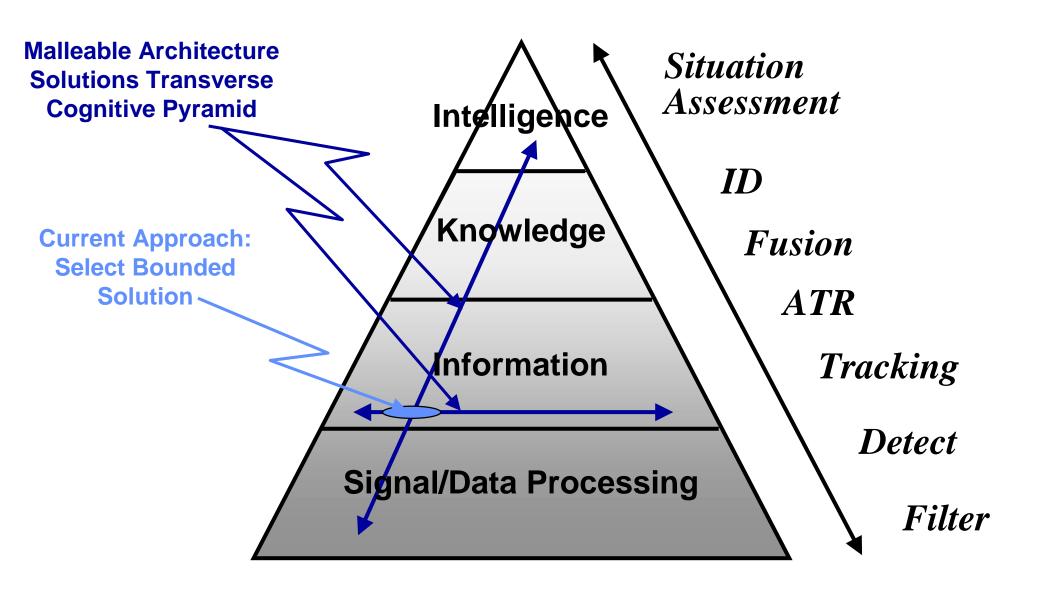


Current Architecture Solutions



New Class of Missions Require a Transversal of the Architectural Space

New Class of Missions Require Application Space Diversity



Mission Aware Embedded Computing Activities

Adaptive Computing Systems





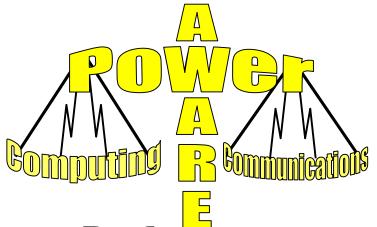


Polymorphous Computing Architectures (PCA)





Power Aware Computing and Communications



Performance

"JIP: Just In-time Power"
The *right* power at the *right* place
at the *right* time

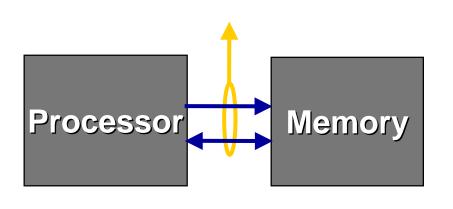
Data Intensive Systems

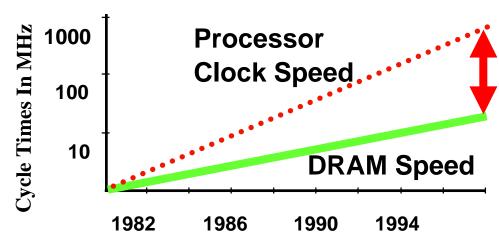
Do for memory

.... What RISC did for processors

Data Intensive Systems

The Problem: Data-Starved Defense Applications



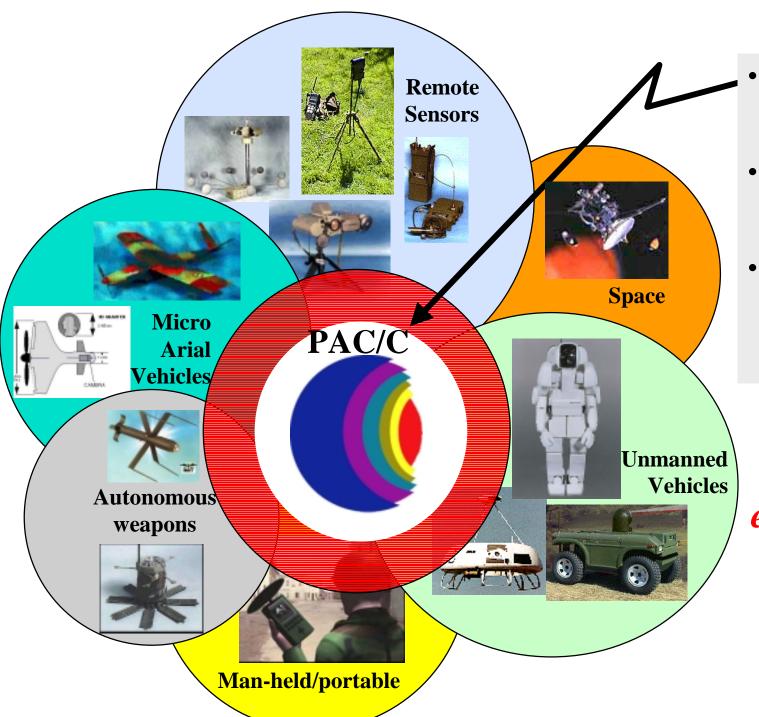


Solution:

- In Situ Processing
- Logic within memory chips manipulates data within the memory subsystem
- Memory within computational streams

- Adaptive Cache Management
- Applications manage memory
 hierarchy so data placement and
 control flow is tailored to application
 specific needs

PAC/C - Enabling Technology



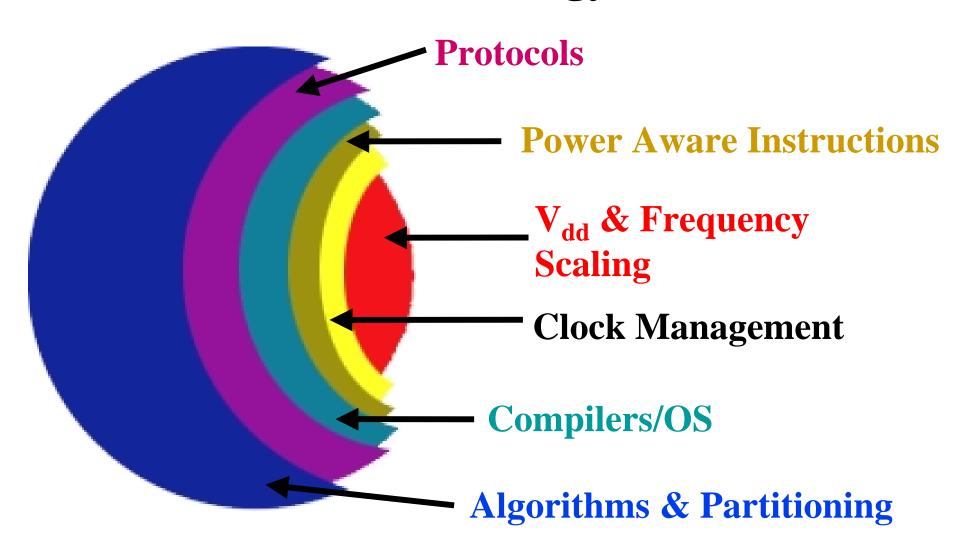
- Implement Power Management at all levels
- Provide a technology tool suite for use by each end user
- •Power Aware technologies are critical across a broad range of applications

Optimize

performance,
energy, and power
demands against
instantaneous
mission
requirements

PAC/C Approach

Power Aware Technology at All Levels



Polymorphous Computing Architectures (PCA)

Enable reactive multi-mission and in-flight retargetable embedded information computing systems that will reduce mission computing payload adaptation, optimization, and verification from years to months to minutes.

Polymorphous Computing

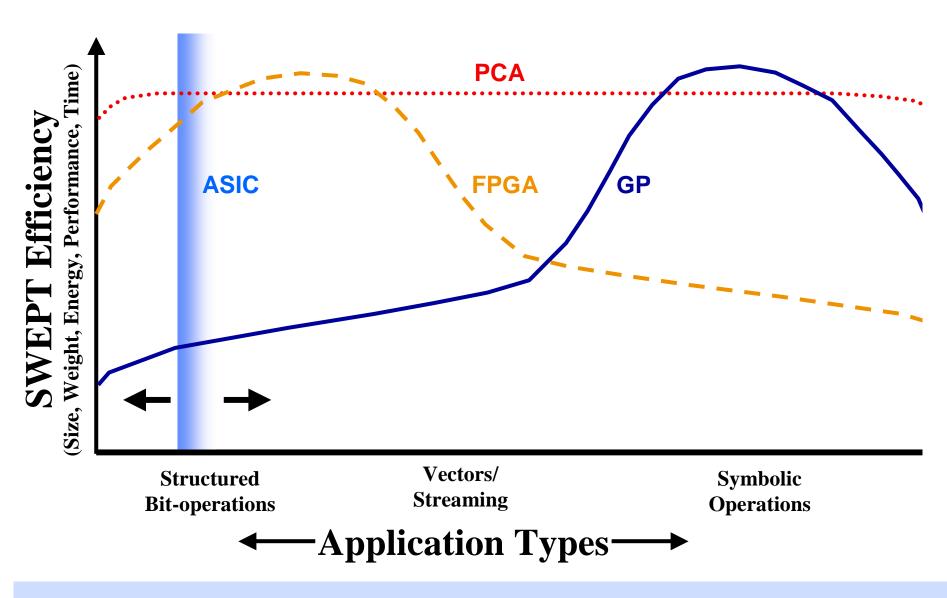


Polymorphic - Adj. having, taking, or passing through many different forms or stages. (Greek polus many + morphe form)

Polymorphous Computing Architecture (PCA)

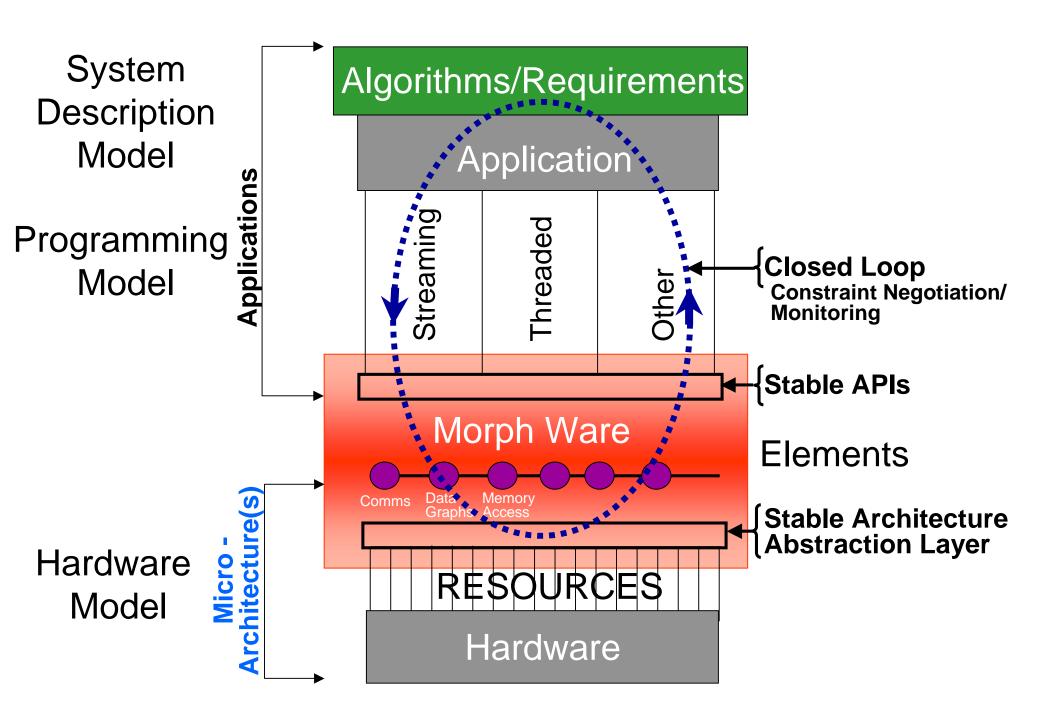
- What will we do? Develop an adaptable (polymorphic) middleware/micro-architecture that can rapidly adapt as required.
- How is this different? Today's embedded computing systems are generally optimized using a static architecture.
- What is the impact? Provide the warfighter the ability to always have access to the best available embedded computer capability:
 - □ Ease of HW upgrade throughout the platform's lifecycle
 - □ Rapid multi-mission/multi-sensor adaptability.
- What is the product? Provide a validated (via prototype testing) suite of polymorphic computing architectures (PCA) technologies for DoD embedded computing applications.

Efficiency versus Application Space



Hard Problem: Optimized Performance Over Broad Application Space

PCA Architecture Concept

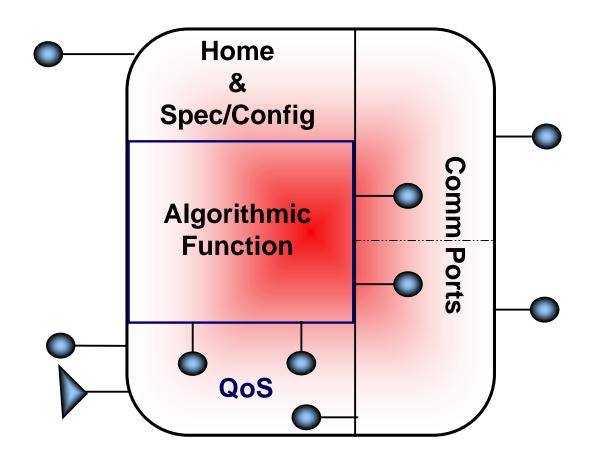


Abstract Hardware Model Presented to Software

- Must present a range of abstractions
 - **□** Compute
 - Vector to multi-processor machines
 - **□** Communication
 - Circuit switch to packet router
 - **Memory**
 - Vector registers to caches
 - **□** Verification
 - Functionality to performance metrics

Support Broad Range of Models

Polymorphous Software Component



Measurable and Verifiable Configurations/Behavior

PCA Enables

- Multi-mission, multi-sensor, and in-mission reconfiguration
- Rapid technology insertion
- Deterministic behavior within SWEPT (Size, Weight, Energy, Performance, Time) constraints
- Component based validation
- Preservation of software investment

Forever Change the Way DoD Develops Embedded Software & Hardware Computing Systems

Summary - Future Directions -

New Ideas

Embedded Computing

Polymorphous Computing

High Performance Scientific Computing → Fill the Technology Research Pipeline?

Multi-Mission Environments and Polymorphous Architectures















Laying the Embedded Computing Technology Foundation for the Dynamic Battlespace